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Specification and Drawings, as originally filed, with Application for Patent Serial No: **2,468,357,** on June 3, 2004, by **DOMINIQUE FEUILTAULT and MARC LAJOIE,** for "System, Device and Method for Feeding Flat Articles".

PRIORITY DOCUMENT

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March 9, 2005

Date

Canada

(CIPO 68)
31-03-04

OPIC CIPO

SYSTEM, DEVICE AND METHOD FOR FEEDING FLAT ARTICLES

BACKGROUND OF THE INVENTION

1. Field of the invention

The present invention relates to apparatus and methods for handling flat products such as printed sheet signatures ("signatures") to feed downstream machinery. More specifically, the invention aims at providing an ultra-high speed, simple and reliable system and method for feeding a signature gathering conveyor of a bindery line for the manufacture of books or the like. The invention contemplates delivering flat articles on a conveyor in a continuous shingled stream or in a generally horizontal hopper pocket and feeding the articles to the downstream machinery one by one by gripping the leading (lowermost) article by its backbone, using separating grippers traveling along a linear path, generally orthogonal to the article stream orientation. Although the present invention will be described by reference to the handling of signatures in a bindery process, it shall be deemed applicable in a variety of applications dealing with flat products in sheet form.

2. Brief description of the prior art

Bindery machinery usually relies on rotary drum gathering systems to pull and pick-up signatures from the bottom of a horizontal stack in a hopper and transfer signatures to build piles collated on either a saddle or pocket conveyor, the piles being fed to the downstream stitching, sewing or gluing operation to produce books or magazines. Alternatively, gripping systems are also used with the assistance of separating tooling such as rotary cam

separators and vacuum plates cooperating to separate the lowermost signature being pulled down from the rest of the pile being supported by the separating device.

Feeding of the hopper was traditionally accomplished manually by an attendant taking a pile of signatures and bending the pile back and forth a few times to ensure proper separation of the signatures. It is also well known in the field to replace the attendant by a feeding conveyor (loader), carrying-out separation reliability with increased through-output and lower operating costs, to deliver the signatures to the horizontal hopper of a gatherer, separated in forwardly inclined shingled continuous stream.

However, feeding the signatures to form a vertical stack in a hopper still requires a complex system to control stack build-up parameters and pick-up one signature at a time to perform the transfer to a gathering conveyor. Many such systems have been developed so far in an attempt to perform these tasks with acceptable yield and through-output, but still with a high level of complexity and proportional cost. For example, signatures are delivered into the hopper by batches through start and stop cycles of the loader conveyer, which generates rapid changes in the load (signature stack) supported by the hopper and the feed system. Miss-feed occurrences may thus be experienced due to poor control of stack's height into the hopper. Actually, the intermediate step consisting in feeding a hopper prior to feeding a gathering conveyor has no justification but historical and feeding said conveyor through a direct transfer from an incoming stream of shingled signatures can yield many advantages.

A few examples of such direct transfer apparatuses have also been taught in prior patents, but still remain complex, mainly because signatures are always picked-up by grippers traveling in the stream direction while signatures are to be transferred to a gathering conveyor running in an orthogonal direction. Therefore, the existing feeding systems remain complex, costly, subject to miss-feeds and limited to a maximum feed rate of 10 000 to 15 000 signatures per hour.

The above review of the prior art clearly shows that the solutions of the prior art contemplating the feeding of bindery gathering conveyors, from an incoming stream of shingled flat articles, still present several limitations and drawbacks. Therefore, there is a need for an improved flat article feeding system obviating such limitations and drawbacks of the prior art devices and methods.

SUMMARY OF THE INVENTION

The present invention overcomes the limitations and drawbacks of the above mentioned inventions of the prior art, and more specifically:

There is first provided a method for feeding flat articles to an article gathering conveyor, said method comprising:

1- advancing said flat articles in a direction in a continuous stream of forwardly inclined shingled articles on a first conveyor;
2- grasping a leading portion of the foremost article; and,
3- transferring said foremost article along a path substantially transversal to said direction, from

said first conveyor to a second conveyor running substantially in the direction of said path.

According to an alternate embodiment of the invention, there is further provided a method for feeding flat articles to an article gathering conveyor running in a direction along a generally linear path, said method comprising:

1. creating a vertical stack of flat articles;
2. grasping a leading portion of the lowermost article; and,
3. transferring said lowermost article in said direction and along a path generally parallel to said linear path, to said article gathering conveyor.

There is further provided a further embodiment of the method for feeding flat articles to an article gathering conveyor, wherein said flat articles comprise folded printed sheets and wherein said leading portion comprises a backbone of said folded sheet.

In a still further embodiment the method comprises an additional step comprising separating at least in part said leading portion from the next upstream article by vacuum prior to the grasping of said portion.

There is still provided a further embodiment of the method wherein separating at least in part said leading portion from the next upstream article by vacuum comprises pulling and holding down at least a corner of said leading portion by vacuum and further separating said leading portion by running a separating device substantially parallel to said linear path above said leading portion, from said corner to the opposite edge of

the article, in order to lift upstream articles to enable the grasping of said portion.

There is further provided a system for the feeding of flat articles to an article gathering conveyor running in a first direction along a generally linear path, comprising: a first feed conveyor running linearly toward said gathering conveyor in a second direction generally orthogonal to said first direction, and at least one gripper device traveling linearly in said first direction along a path generally parallel to said linear path, wherein said gripper can grasp a leading portion of a downstream article and transfer said article onto said gathering conveyor.

According to a further embodiment of the system there is provided a system for the feeding of flat articles to an article gathering conveyor running in a direction along a generally linear path, said system comprising: a flat article loading device presenting flat articles with their main plane generally horizontally oriented and with a lowermost article, and at least one gripper device traveling linearly in said direction along a path generally parallel to said linear path, wherein said gripper can grasp a leading portion of a said downstream article and transfer said article onto said gathering conveyor.

In a further embodiment of the system, the gripper device further comprises a separating wedge portion comprising a separating edge facing towards the gripper's travelling direction.

In a further embodiment of the system, said first conveyor further comprises an articulated vacuum pick-up arm and a vacuum retaining plate, whereby said leading

portion of the most forward article is picked-up by said pick-up arm and retained by the vacuum plate to separate at least in part the leading portion of said article from the next upstream article.

In a further embodiment of the system, the flat article loading device comprises a hopper pocket to hold a vertical stack of flat articles.

These objects and other objects and features of the present invention will become apparent through the following description that will be carried out by reference to the appended drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view of the system according to a preferred embodiment of the present invention, showing a vacuum pick-up arm pulling down a leading edge of a foremost signature to create a space between the leading and the next upstream signatures.

FIG. 2 is a perspective view of the system according to a preferred embodiment of the present invention, showing a gripper mounted separating wedge running across a space created between the foremost signature and the next upstream one.

FIG. 3 is a perspective view of the system according to a preferred embodiment of the present invention, showing a gripper grasping the reference corner of the leading portion of the foremost signature.

FIG. 4 is a perspective view of the system according to a preferred embodiment of the present invention, showing the gripper pulling the foremost signature.

FIG. 5 is a perspective view of the system according to a preferred embodiment of the present invention, showing the leading signature fully extracted from an incoming shingled stream and being dropped onto a gathering conveyor.

FIG. 6 is a zoom-in of Figure 3, to better show details of the closed separator-gripper device.

FIG. 7 is a detailed perspective view of the separator-gripper device in an open position.

FIG. 8 is a detailed perspective view of the vacuum pull-down and retaining assembly mounted at the outlet of the feed conveyor.

FIG. 9 is a perspective view of the system according to a preferred embodiment of the present invention, wherein incoming signatures from a loading conveyor accumulate in a thin vertical stack in a pocket like accumulator.

DETAILED DESCRIPTION OF THE INVENTION

A preferred embodiment of the method, apparatus and device for feeding flat articles according to the present invention will now be described in detail referring to the appended drawings.

Referring to FIG.1, there is provided a feed system generally identified by numeral **1**, which is designed to feed incoming signatures **2** to a gathering conveyor **10** forming vertical piles of different signatures being forwarded to an downstream bindery equipment such as a binding station (not shown) where signature piles are pasted together to form a book or magazine. The system comprises at least one feed conveyor station **3**, each station feeding one of the signatures being successively

collated to form piles in successive pockets of the gathering conveyor **10** separated by pushing rods **12** (see Figure 3). Obviously, a plurality of such feed conveyor stations **3** placed in parallel transversally to the gathering conveyor direction **11** are usually required to individually deliver each one of the different signatures to be assembled together to form the book or similar product.

The system further comprises a plurality of separator-gripper devices such as **60**, said devices being assembled to a driving chain (see chain link **70** shown in Figure 7) synchronized with the gathering conveyor **10**, so that said devices travel along a linear path parallel to the orientation of the gathering conveyor **10** and at the same speed and in the same direction **11** as pushing rods **12**. The spacing of the grippers **60** along the driving chain is the same as that of the feed stations **3** so that each station is individually serviced in parallel by one gripper according to common simultaneous cycles. Therefore, one of each of the signatures required to form the book or magazine are simultaneously dropped into a separate accumulating location (pocket) provided ahead of each pushing rod **12** on the gathering conveyor **10**. Separator-gripper devices **60** comprise three guiding pulleys **61**, a pair of upper pulleys and a lower pulley, (Figure 7) to travel on a guiding rail **13** assembled to the gathering conveyor **10** and also extending in the same orientation.

Feed conveyor station **3** comprises a motorised belt **34** for supporting and advancing the stream of forwardly inclined shingled signatures **2** in direction **35**. The general structure of such feeders is well known by individual of ordinary skill in the field. However, feed conveyor station **3** of the present inventive system **1** is further

provided with special tooling at the downstream end thereof. Said tooling comprises an actuated vacuum pick-up arm **32** provided with a plurality of suction cups such as **33**, and a perforated vacuum retaining plate **31**, both extending across the width of feed conveyor **3**, parallel to direction **11** (see details on Figure 8 showing vacuum manifolds **36** providing vacuum in perforated vacuum retaining plate **31**). Vacuum retaining plate **31** comprises openings **37** to enable vacuum cups **33** to contact the underside of the leading edge **20** of the foremost signature when in their uppermost position.

It is worth mentioning that the movement of vacuum cups such as **33** can be actuated individually as well as the suction in each vacuum cup, through appropriate actuation and control systems. A first advantage of that structure is to enable the use of a limited number of suction cups when a shorter signature is being processed, thus avoiding air admission from suction cups located outside of the signature surface. Also, to speed-up the feed rate, only one suction cup (ex. **33a** in Figure 8) corresponding to the position of the upstream corner (with respect to the direction of gathering conveyor **10**) of the leading edge **20** of the signatures can be actuated to pull down that corner while the previous signature is still being pulled-out from the stream in the direction of gathering conveyor **10** and does not yet clear the other vacuum cups located further downstream with respect to that direction. For similar reasons, the vacuum in manifolds **36** of vacuum retaining plate **31** could also be individually actuated.

As shown in Figure 9, feed conveyor **3** may also comprise additional tooling such as back-gauge **90** and stop plate **91**, and angular vacuum retaining plate **31** extends horizontally upstream, slightly below the level of belt **34**, as non-perforated supporting plate **92** to form an accumulating zone

wherein some signatures **2** may be accumulated in a thin vertical stack. As will become obvious from reading of the following description, the system **1** of the present invention may optionally be used with or without such a thin accumulation, or even with a hopper pocket carrying a vertical pile of signatures fed manually without the help of a feed conveyor. In any such alternate embodiment, the above described vacuum separation tooling remains unchanged, cooperates in the same manner with the signature supporting surface and engages the lowermost signature in the same way.

Turning now to Figure 7, the separating-gripper device **60** will be described in more details. Separating-gripper device **60** comprises a fixed top jaw member **62** terminated on its downstream end by a separating wedge portion **63** comprising a sharp separating edge **64**. An actuated lower jaw member **65** comprising a friction pad **66** cooperates with fixed top jaw member **62** to provide an individually controllable flat article gripper. Closing of the gripper is accomplished by laterally pushing on roller **67** of rocker **68** causing connecting rod **69** to be pulled and in turn pivoting lower jaw **65** upwards. When pressure is released, a spring member returns the gripper assembly to its normal open position. Individually controlled actuation of the separating-gripper devices **60** is preferably accomplished through linear cam member **14** extending parallel and close to guiding rail **13**, and being periodically hit by roller **67** when gripper **60** in moving on rail **13**. Obviously, actuation of the grippers could also be accomplished using electrically or pneumatically powered actuators and an appropriate control system, according to techniques well known to those of ordinary skill in the art.

To ensure its mobility, separating-gripper device **60** further comprises three pulleys **61** to travel on upper and

lower edges of guiding rail **13**. Device **60** is driven over a linear path in direction **11** through a chain connected to chain link **70**, said chain being preferably the same one driving pushing rods **12** of gathering conveyor **10**, in order to ensure optimal synchronisation.

In operation, the system functions as follows, according to a preferred method of the present invention:
Conveyor **3** advances shingled signatures **2** in direction **35** until the leading portion **20** of the foremost signature exceeds the downstream end of conveyor belt **34** to lye above vacuum retaining plate **31**;
Vacuum pick-up arm **32** is actuated to bring suction cups **33** (or suction cup **33a** alone) in contact with the lower surface of said leading portion **20** of the signature, apply vacuum momentarily at suction cups **33** (or **33a** alone) through a synchronized rotary valve and pull the signature down (or its upstream corner only) in contact with permanently activated vacuum retaining plate **31**, so that at least an upstream edge **21** of said leading portion is separated from upstream signatures, creating a space (see Figure 1);
Through appropriate timing of the system **1**, one of the traveling separating-gripper devices **60** is at that moment approaching edge **21** and sharp edge **64** of separating wedge portion **63** gradually enters said space (gap) and gradually increases spacing while supporting upper signatures (with potential help of actuated retaining needles or the like) as the gripper **60** progresses between the signatures in its open position (see Figure 2);
Once approaching the downstream edge **20** of said signature leading portion, roller **67** hits a higher portion of linear cam **14** which causes closing of separating-gripper device **60** and grasping of the downstream corner of the leading edge of the foremost (lowermost) signature (see Figure 3);

Gripper **60** pursues its travel along its linear path in direction **11** until the signature fully clears signature stream **2** - upper signatures are prevented from sliding in the pulling direction through an appropriate stop device (see Figure 4) - in the embodiment of Figure 9, stop plate **91** provides that stop;

Finally, once the signature is completely extracted from the stream **2**, roller **67** drops on a lower portion of cam **14** causing gripper **60** to open and release the signature on a buffer shelf (not shown) above a pocket of gathering conveyor **10**, just before the signature is dropped on top of the signature stack in the pocket and carried by push rod **12** (see Figure 5) to be forwarded to a downstream bindery equipment such as a binder applying glue to the edge of the stack of signatures in a pocket to form an assembled product, such as a book;

As soon as the grasped signature has cleared vacuum cup **33a**, a new cycle can begin, starting with actuation of vacuum cup **33a** through pick-up arm **32** to pull down the upstream corner of the next lowermost signature, while belt **34** of the feed conveyor **3** had automatically previously advanced said signature to the pick-up position.

Providing a plurality of feed conveyors **3** equipped as described above and at least as many separating-grippers **60** travelling transversally to stream direction **35**, a complete system is provided whereby a plurality of different signatures can be handled and successively dropped in a pocket to form a stack according to the printed product to be assembled.

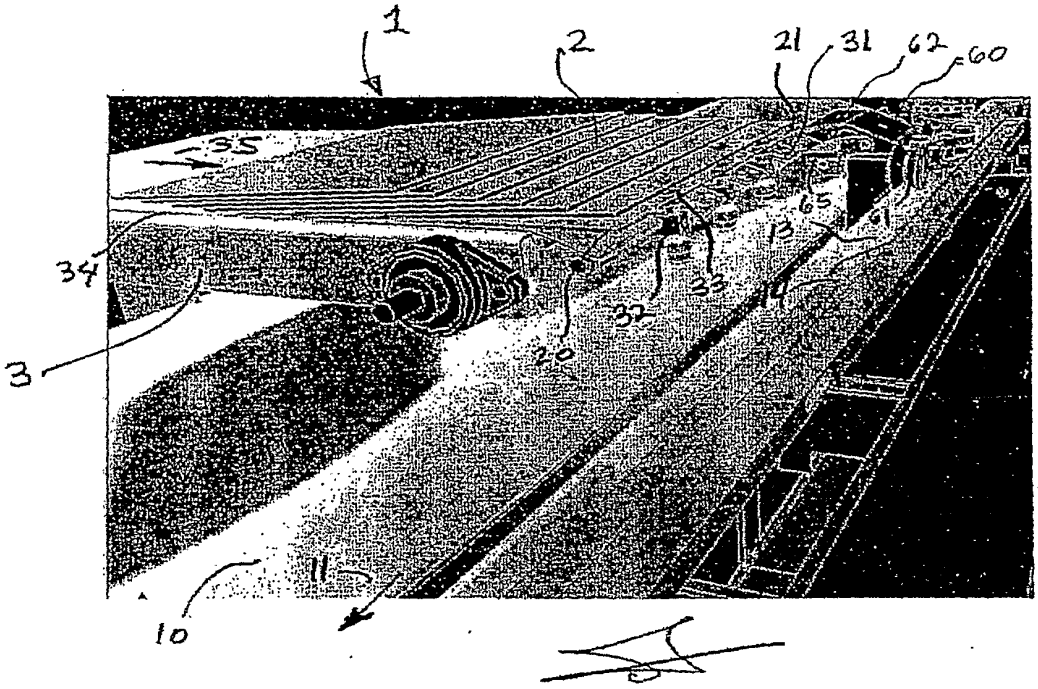
It should be noted that the system of the present invention described above by means of a preferred embodiment thereof, advantageously provides direct transfer of any flat article fed in shingled stream to a

gathering conveyor, without transiting through a hopper and without critical make-ready operation. Also the system providing a combined article separating-gripping device travelling linearly in the direction of the gathering conveyor (transversally to the stream direction) enables fast action over very short distances and with minimal handling of the article. Therefore, very high speeds in the order of 40 000 articles per hour can be achieved by the feed system with high yield, using very simple, reliable and low cost and low maintenance equipment. Such a speed would enable feeding two biding stations using a tandem of gathering conveyors (superposed or otherwise cooperating).

Therefore, one can contemplate that the method and apparatus of the present invention avoid costly interruptions of the bindery line due to miss-feeds usually occurring at the vacuum belt bed conveyer signature feeder because of an excessive steady or momentary load in hoppers, or because of distortions usually created on the top lower sheets of signatures by the mechanical processing.

Although the present invention has been described by means of preferred embodiments thereof, it is contemplated that various modifications may be made thereto without departing from the spirit and scope of the present invention. Accordingly, it is intended that the embodiments described be considered only as illustrative of the present invention and that the scope thereof should not be limited thereto but be determined by reference to the claims hereinafter provided and their equivalents.

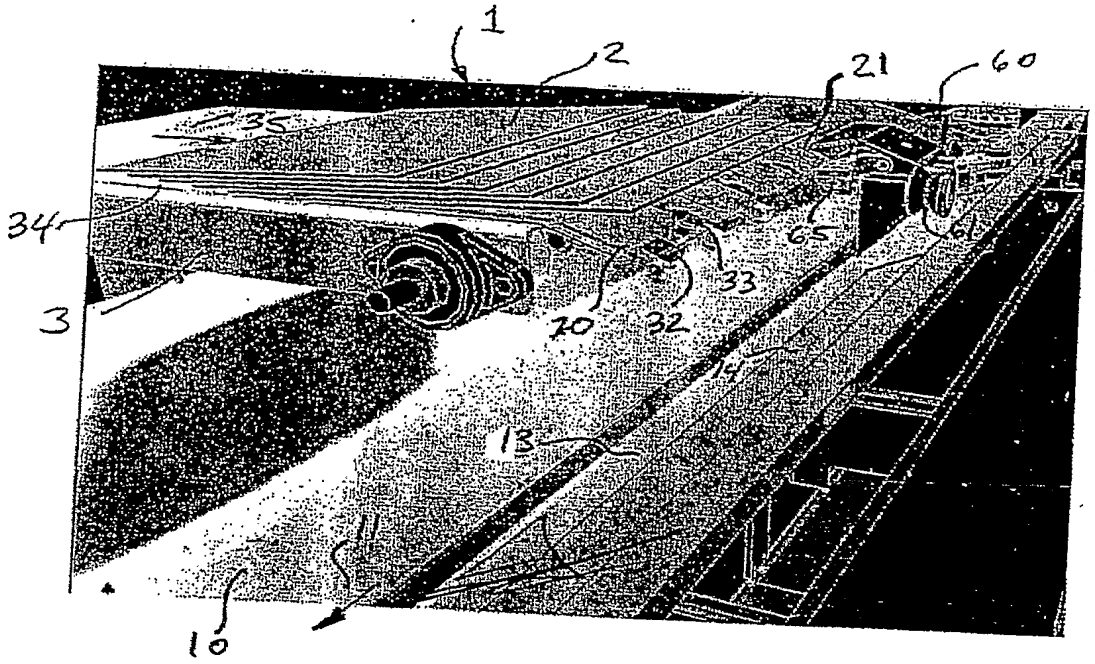
Inventor



Sequence 1 :

While the gripper advances, the suction cups rise up and bring back down the signature just before the gripper enters the accumulation zone.

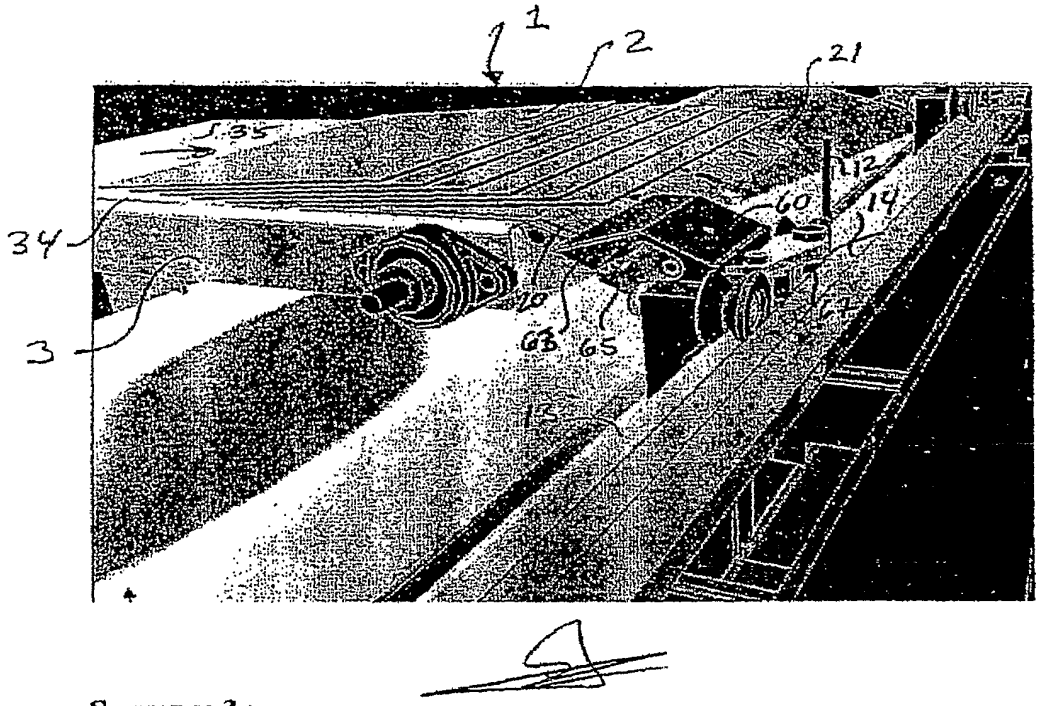
Fig. 1



Sequence 2 :

Once the signature is in its down position, the separating wedge located at the leading edge of the gripper enters the space created between the signature in the down position and the signature stack just above. The stack is retained in the up position by a system of needles, tongues or any other retaining device. At this point the signature has no other choice than to be grabbed by the gripper since it is located within the gripping jaw of the gripper.

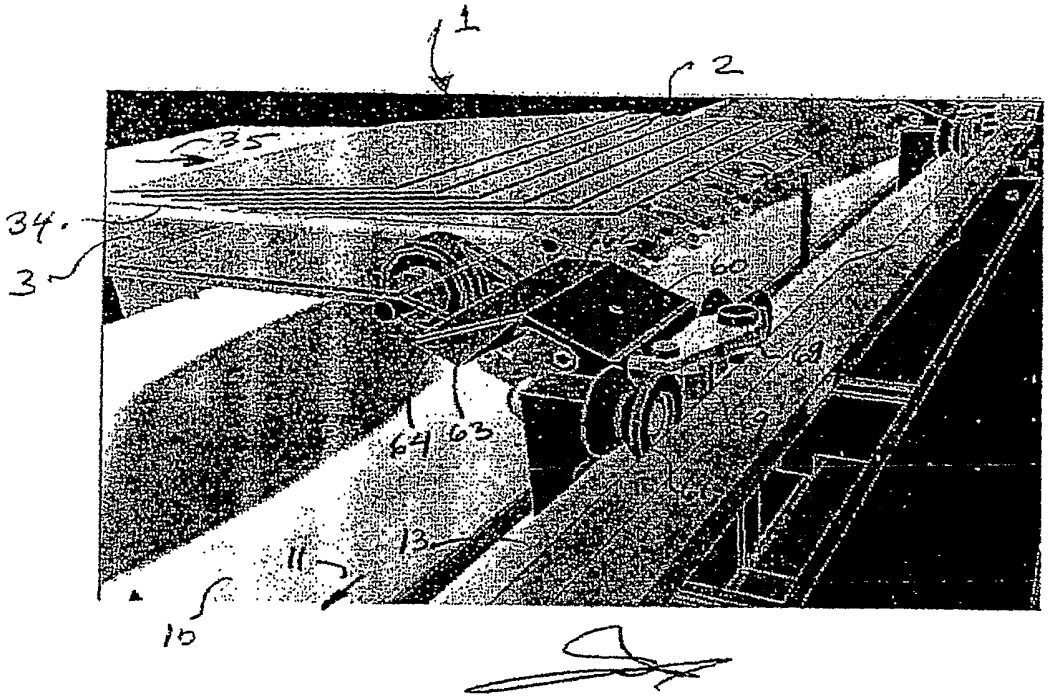
Fig. 2



Sequence 3 :

Once the gripper reaches the reference corner, the gripper jaw is closed and grabs the signature. This action is performed by a linear cam that pushes the gripper arm.

Fig. 3



Sequence 4 :

The gripper pulls the signature out of the accumulation zone. The signature stack is retained by a device that allows only the lowermost signature to be pulled out of the pile.

Fig. 4

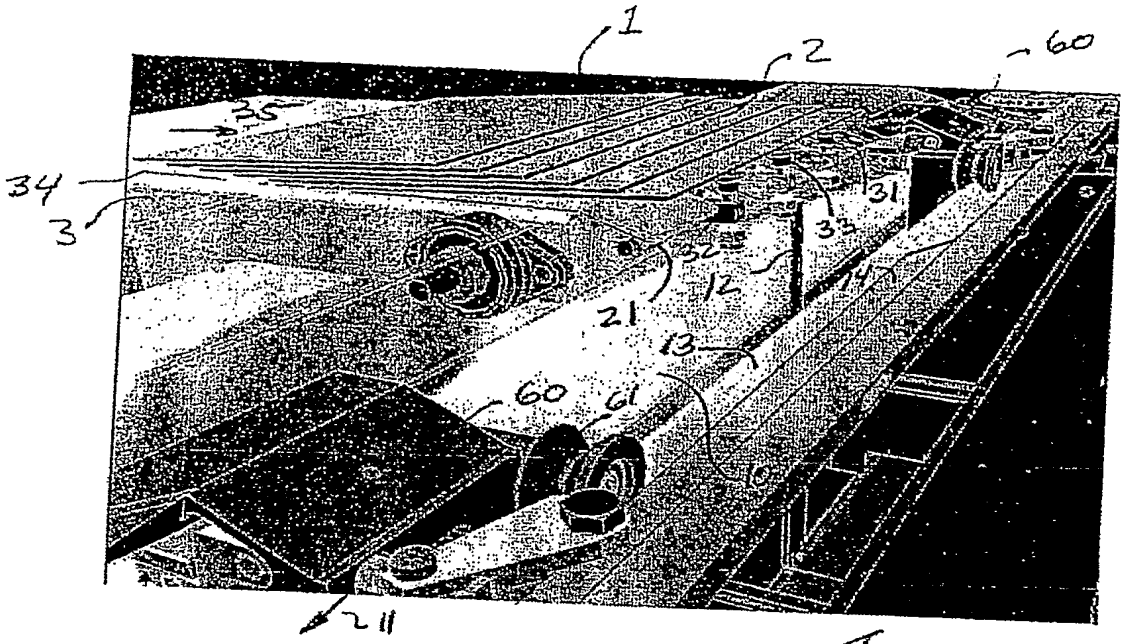


Fig. 5

Sequence 5 :

Once completely out of the accumulation zone, the gripper releases and deposits the signature downwards onto the gatherer raceway and ultimately into a binder.

Although it is not illustrated in these drawings the signatures are actually deposited onto a waiting tray just before a pusher pin from the gatherer raceway pushes the signatures. This is a necessary procedure in order for each signature to be properly dropped on top of signature stacks already located in raceway.

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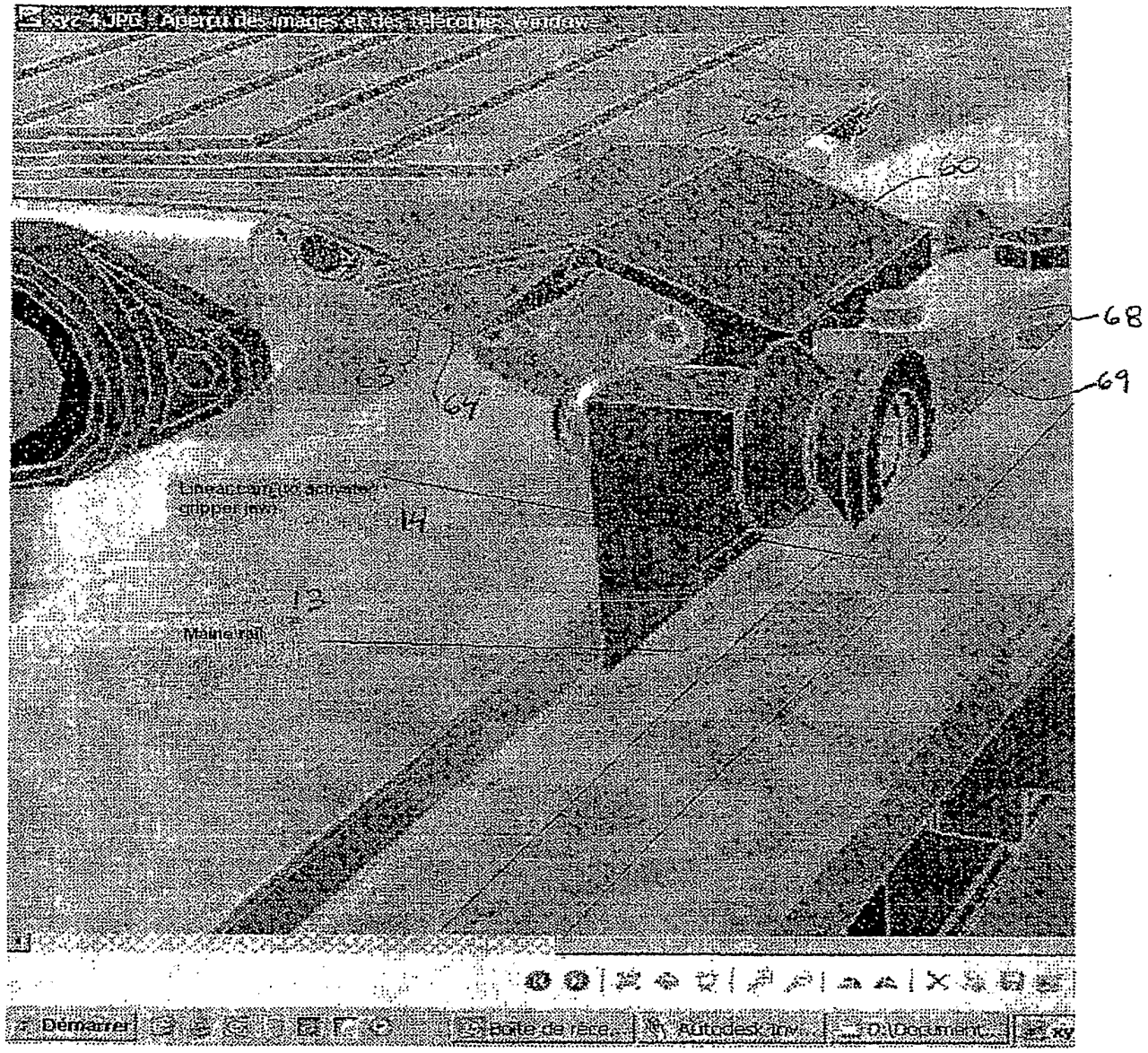

Fig.6

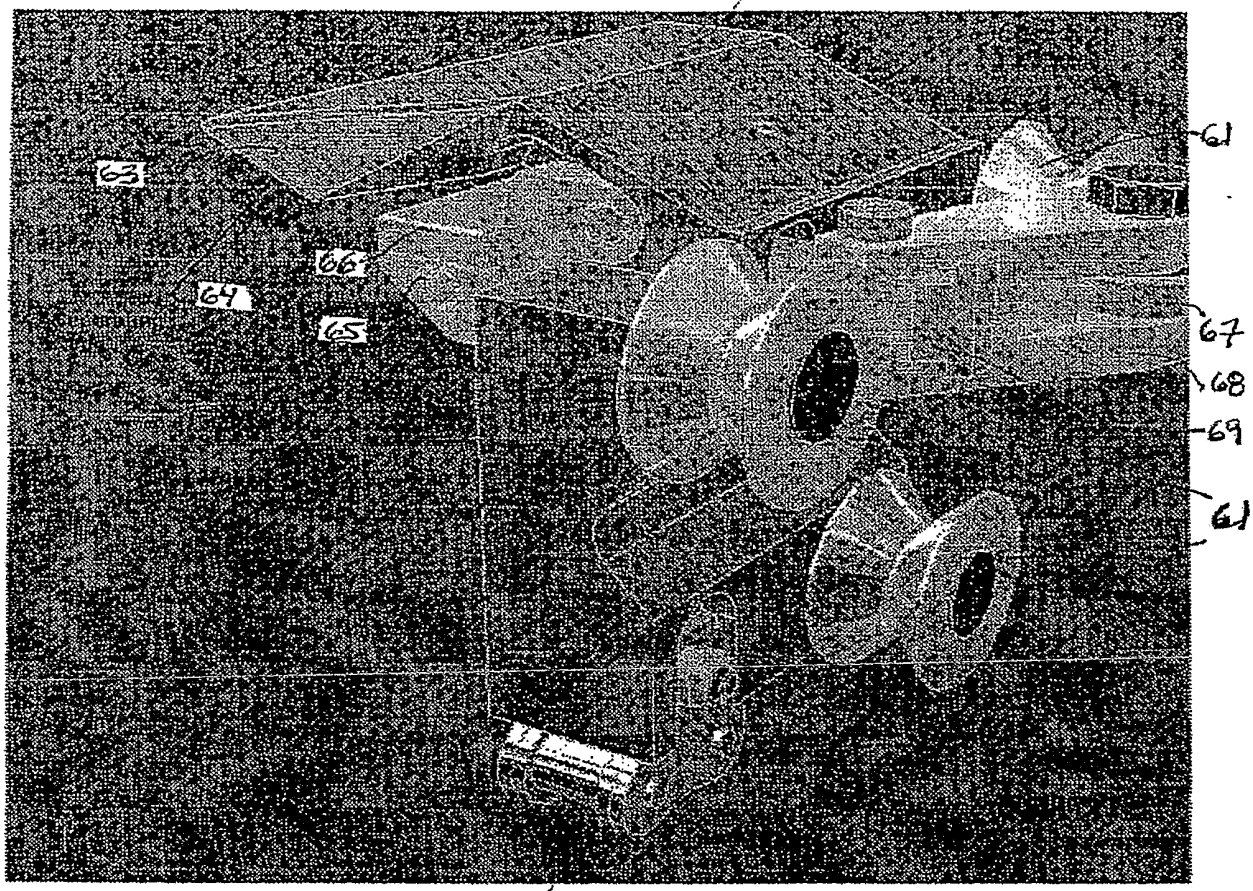

Fig. 7

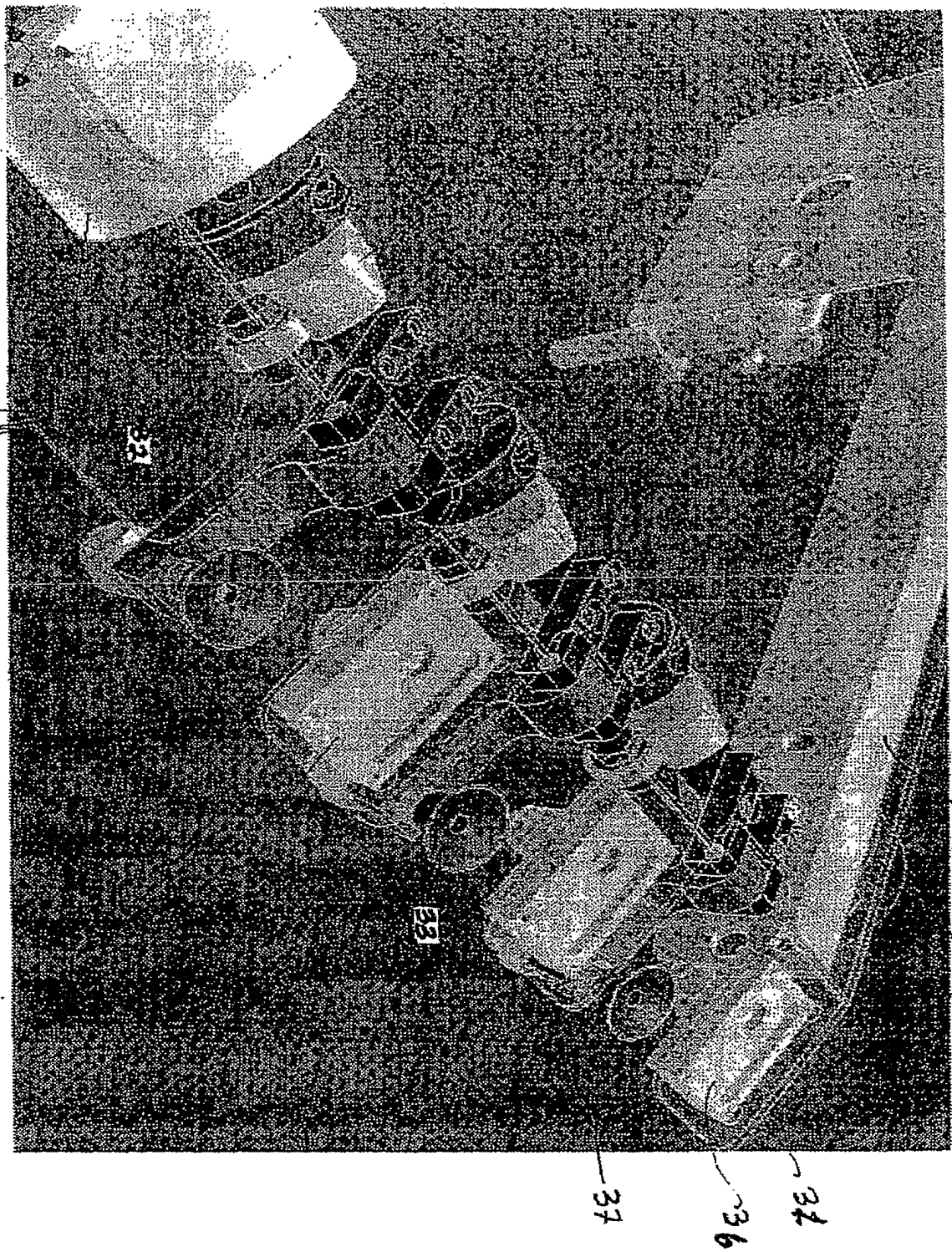

Fig. 8

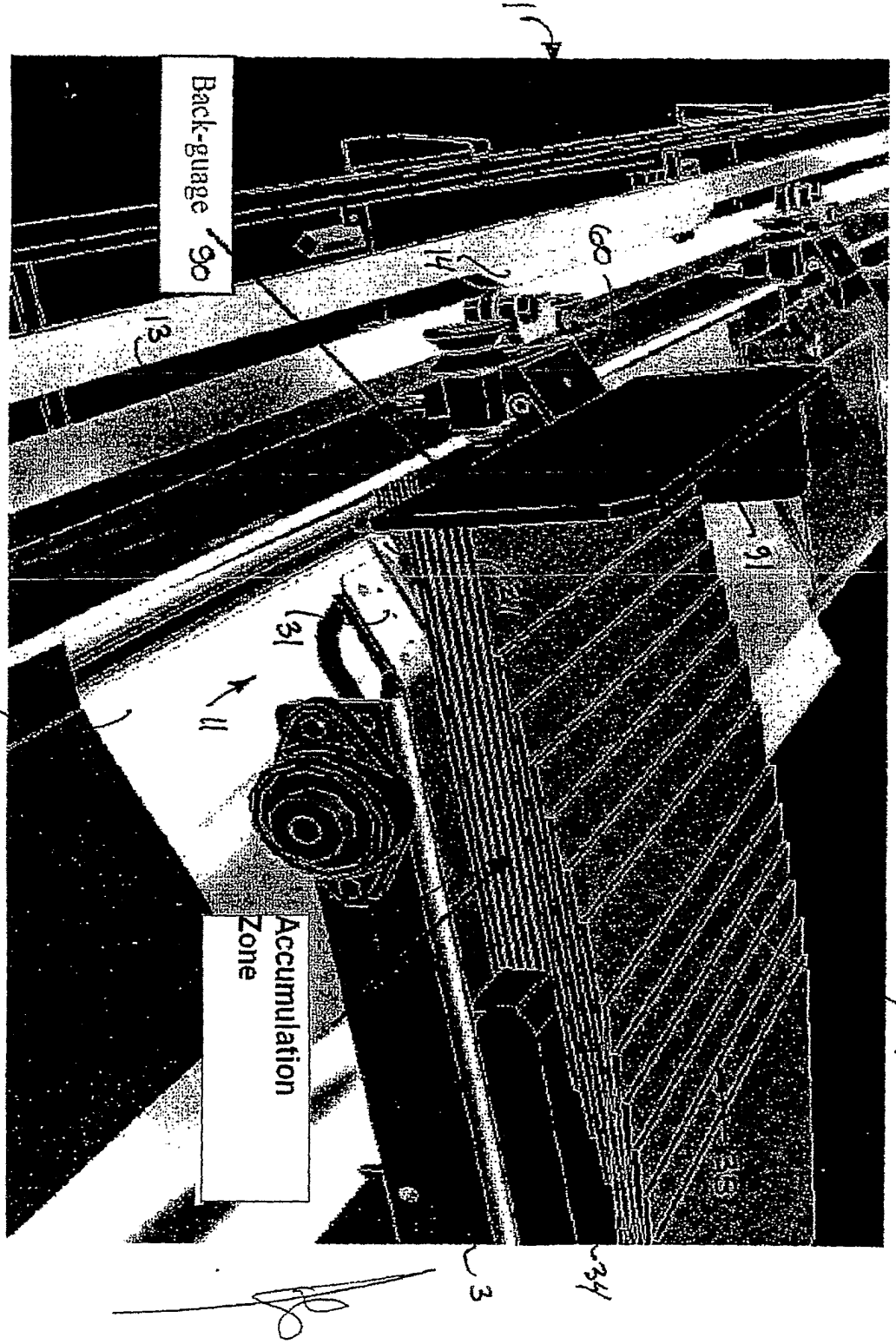

Fig. 9